Digitally Speaking

By Cory GB Sickles WA3UVV wa3uvv@gmail.com

M17 – The Seventh Methodology

When DV (Digital Voice) first became "a thing" on the amateur radio bands, P25 (Phase 1) led the way. This was mostly enjoyed by Motorola radio technicians and enthusiasts of the "Bat Wing" product line. P25 is used extensively by Public Safety (Police, Fire, EMS, etc.) concerns. As ham radio has a long history of "improvise, adapt and overcome," and P25 radios could cover the 144 MHz and 440 MHz bands, small pockets of DV began to emerge.

Later, the JARL (Japan Amateur Radio League) would introduce D-STAR and Icom would take on the task of introducing the first DV methodology designed by and for hams. In time, D-STAR began to gain forward momentum, eventually becoming the de-facto standard when radio amateurs were discussing digital radio.

Along the way, other commercial LMR (Land Mobile Radio) DV options entered the marketplace, with DMR (Digital Mobile Radio / Digital Migration Radio), TETRA and NXDN. DMR has also become a popular choice, while NXDN is still something of a niche interest. TETRA has yet to gain any traction in North America, but there are many enthusiasts in Europe.

As both TETRA and DMR utilize TDMA (Time Domain Multiple Access) technology, DMR supports two time slots, while TETRA supports four. Also, TETRA mobile radios can be programmed to be used as repeaters, moving incoming transmissions from one time slot to another—allowing for real-time, same frequency repeating.

System Fusion arrived on the scene in 2014 and Yaesu introduced a complete product line of portable and mobile radios, along with a repeater and networking scheme. The company's marketing plan propelled it within 18 months to what D-STAR had achieved in five years, as to number of repeaters in operation.

Over time, I have often mentioned that System Fusion and D-STAR are the only FUBU (For Us, By Us) fully fleshed out DV methodologies. I have omitted that notation for a while, as this is no longer true. Along with the six previously mentioned DV methodologies we also have M17.

M17 is the brainchild of Wojciech Kaczmarski SP5WWP. He, along with a team of volunteers with various professional disciplines, known as the M17 Working Group, have been putting forth a respectable effort into developing a robust protocol, with support for radios, repeaters and networking. Lately, they have made significant strides in accomplishing this and more. Wojciech's stated reason for creating M17 has to do with developing and promoting a standard that is non-proprietary. He also wants to take all of the DV methodologies that have come before and "…kick the proprietary protocols off the airwaves…" He also mentions the desire to have DV radios that do not have to be licensed.

This modest looking device – in my opinion – was the most revolutionary "real" item at Hamvention 2023. The Module 17 allows you to add this digital voice methodology to virtually any analog transceiver, which possesses the ability to support high-speed (9600 bps) data. (Courtesy: WA3UVV)

Before I delve any deeper into the technical aspects, I feel compelled to address the "non-proprietary" ideology he expresses.

Passing again through the list of DMR, D-STAR, NXDN, P25 (Phase 1 and 2), System Fusion and TETRA—note that none of these are tied to only one manufacturer with a license required in order to produce and sell compatible equipment. If Wojciech's premise was true, then we would not have the numerous "hot spot" networking nodes and protocol translators that exist. We would not be able to add a board to an analog repeater and upgrade it to digital voice operation in one or more of our favorite flavors. To be clear, none of the producers of the hardware and software involved is being forced into paying licensing fees.

Every technical detail of the above DV methodologies has been published in what is known as a CAI (Common Air Interface). The CAI enables anyone who has the required skill sets and finances available to them, to produce prod-

While produced as a cheap DMR radio, the MD-380 and other portables in the series can be used to experiment with M17. I have a pair of VHF monoband units (so old that they are branded "Tytera") and a third UHF model. All are underused. One could be re-tasked for use with a newer DV methodology. (Courtesy: WA3UVV)

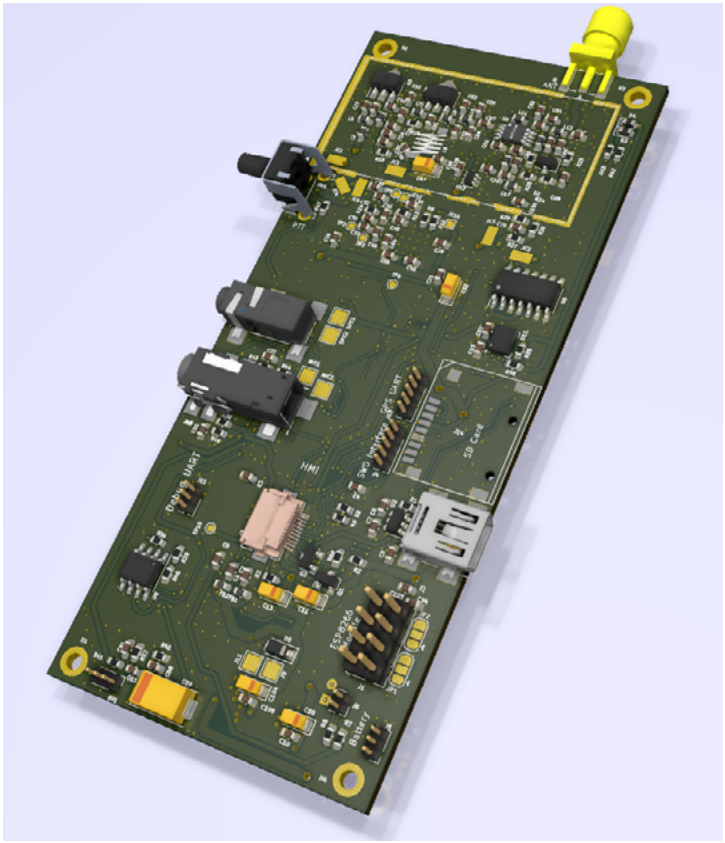
ucts that are compatible with other products supporting the technical standards as detailed within the CAI. This does not mean that a given manufacturer is obligated to reveal any IP (Intellectual Property) that is specific to the software / firmware / hardware designs utilized in a product. But such information is not a necessary requirement for someone else to independently create the needed software / firmware / hardware that might comprise the IP for their own product.

I realize that the task of designing a radio transceiver, choice of components, production of an enclosure, user interface, operational software / firmware and the numerous concerns that go into such an effort are daunting for most. But that does not mean that it cannot be done and certainly does not mean that the limiting factors concern unpublished specifications and non-existing license fees.

Thus, the premise set forth in the M17 purpose statement would appear to be somewhat flawed, at least in my humble opinion.

Now that I have cleared the air – I hope – let us move on to what makes up the M17 protocol set. At its heart, M17 utilizes a C4FM / 4FSK (four carrier frequencies incorporated in combinations) approach, akin to other DV methodologies such as DMR, NXDN, System Fusion and so on. It also utilizes a FDMA (Frequency Division Multiple Access) scheme, in other DV methodologies, with the notable exceptions of DMR and TETRA. The deviation is stated to fit within 9 kHz of bandwidth. Thus, 12.5 kHz channel separation is possible.

The data rate is 9600 bits per second, or 4800 di-bit symbols per second. The M17 protocol supports voice and data. Communications currently is supported with radios,



Work is underway to produce a portable transceiver that natively supports M17. This illustration gives you some idea of the advantages to an SDR approach. (Courtesy: www.M17project.org)

repeaters and networking nodes. The protocol is also designed to be extensible, as new additions and capabilities are incorporated. Further, the M17 protocol is a FUBU concept, optimized toward amateur radio and the way that radio amateurs tend to communicate. The CAI of the M17 protocol set is available to view or download at M17 Protocol Specification - M17 Project Specification.

The M17 CODEC (enCOder DECoder) is based on the FreeDV software vocoder. FreeDV was designed for use on HF and as such, lacks a number of items necessary for a complete DV methodology on our VHF and UHF bands. The good news is that this extended variant remains an Open Source project, encouraging experimentation from the M17 user community

Of special note are the embedded bit interleaving, binary Golay Code and punctured convolutional code. All of the word salad translates to something that ensures a low BER (Bit Error Rate) and high number of transitions in the baseband modulation. Suffice it to say that some very intelligent and well-developed effort has gone into M17's encoding / decoding processes.

As with D-STAR, M17 also offers a low-speed data channel for text messaging, which can come in quite handy in a number of situations. Also, GPS / GNSS (Global Positioning Satellite / Global Navigation Satellite System) positional telemetry is passed. This could be bridged to the APRS network, in much the same way as D-STAR's DPRS can be converted to show up there.

Historically, cheap radios such as the VHF / UHF MD380 and GD77 DMR portables have been pressed into service with custom downloads and minor hardware modifications, in order to function as M17 transceivers. More recently, prototypes of a TR-9 "from the ground up" portable have been utilized for M17, with the ultimate goal of producing a commercially available product that is complete and ready for use.

The efforts of the M17 Working Group was rewarded earlier this year with a rather substantial grant from ARDC (Amateur Radio Development Communications). The ARDC does not hand out funding on a whim. So this award is certainly a recognition of what the M17 Group has accomplished so far and what they are poised to achieve in the future.

Over time, I have formed a collection of more than two dozen DV portables and nearly that number in mobile transceivers. They represent every notable flavor of DV with the exception of M17. For that, one of my original monoband DMR portables – with M17 firmware – suffices. As commercially available transceivers arrive on the market, I will be interested in those, as well. However, there was something that I saw at the M17 booth at Hamvention this year that most definitely demanded my attention.

Ever since the first multi-methodology, dual-band, DV transceiver was announced, I wondered why the announcing entity didn't skip the RF side of the equation and simply concentrate on the vocoder hardware and software. None of the companies working on such a project ever produced a tangible result, as they underestimated the design demands. Not that it can't be done, but simply that they were not the ones to accomplish it.

When I saw what was being featured at the M17 booth, I finally saw concrete evidence of what I was hoping for. Module 17 is an accessory for almost any analog mobile transceiver that has provisions to interface with a high-speed (9600 baud) data stream. Many of us use this port for high-speed TNC (Terminal Node Controller) connections. For those who prefer to build up an inexpensive DV repeater out of mobiles and the STM32-MMDVM interface, those high-speed connections are necessary.

But finally, someone—namely the M17 Group—made the effort to create an external DV accessory. Most importantly, they are the first to succeed in such an effort. Module 17 can be acquired as a board-level solution, but my understanding is that soon it will be available as more of a plug-n-play item, complete with enclosure.

With a DE-9 connection on the rear panel that cables to your particular radio, you can then attach a speaker / microphone that is Kenwood compatible and find yourself enjoying M17 QSOs, without the need to purchase another radio. An external speaker can also be plugged into Module 17, if you want a bit more audio than you can obtain from a speaker / microphone. One nice thing about the Kenwood speaker / microphones that I purchased for my TH-D72 and TH-D7 portables is that they have a volume control. That makes audio control that much easier.

Newest 25 M17 Repeaters.

Click a row to view the repeater

SR5MS	Nowy Dwór Mazowiecki	Poland (PL)
DM0BT	Bayreuth	Germany (DE)
VK3RCQ	Junortoun	Australia (AU)
GB3NU	NOTTINGHAM	United Kingdom (GB)

Latest 25 Updated M17 Repeaters.

Click a row to view the repeater

SR5MS	Nowy Dwór Mazowiecki	Poland (PL)
GB3NU	NOTTINGHAM	United Kingdom (GB)
DM0BT	Bayreuth	Germany (DE)
VK3RCQ	Junortoun	Australia (AU)

According to the RepeaterBook Database, there is now a handful of M17 capable repeaters in North America and Europe. (Courtesy: RepeaterBook)

If I chose to add a Module 17 to one of my Yaesu FT-8900r quad-band transceivers, I could then be enjoying M17 on 50 MHz and 29 MHz. Who is up for some M17 DX?

Taking the concept further, one could conceivably attach a Module 17 to an existing System Fusion or D-STAR radio with the high-speed port (such as an Icom IC-2820A or Yaesu FTM-400DR) and add an extra DV methodology without needing to find additional interior space for another transceiver or being required to attach another antenna to the vehicle. That is a very significant breakthrough and I trust you see why.

Although it runs contrary to the M17 edict, those with the talent to create multi-methodology hot-spots should have little difficulty in adding other flavors of DV to Module 17, as long as there is enough memory and other resources to support such extensions of function. In the spirit of M17, this and more can be accomplished without the need for a DVSI vocoder chip, thus extending the open source design.

My personal belief is that this was the most innovative and original idea brought to life at this year's Hamvention.

With an M17-native portable and the Module 17 as an add-on, I expect we will see more and more of a presence of M17 on repeaters and linked systems, as well. At present, there are four M17 repeaters showing in the North American RepeaterBook database, located in Connecticut, Oklahoma, Tennessee and New Hampshire. In Europe, I found another four, located in Austria, Germany, Great Britain and Poland. Of note, most of those repeaters also support DMR, D-STAR, NXDN and System Fusion.

The population of M17 machines represents a minuscule percentage of all DV repeaters today; yet apparently

four times more of them than TETRA machines in North America. With these innovations and others that are sure to follow, what sort of growth will M17 enthusiasts drive in the next year or the next five years? It should be interesting to see.

If you and just one friend in your local amateur radio club have at least two MD-380s collecting dust or you would like to invest in some Module 17s, then load up some new firmware or make up some cables and conduct comparative experiments, while giving M17 a workout. That, in a nut shell, is how I started experimenting with Yaesu's C4FM, well before it was labeled as System Fusion. Just two radios and two hams, willing to try something new. If you can get others interested, then you have the makings of a group experiment and more enthusiasts with collective enthusiasm.

As with the early and exciting days of FM on the two-meter band, there is plenty of fun to be had on simplex channels. You do not need a repeater. However, if enough of you are having fun and want to extend your coverage, then affordable repeater solutions await you.

Ham radio is about many, many things. Experimentation is but one of them and I encourage you to do your experimentation together, as it also builds friendships and camaraderie within our ranks.

Final thought on M17 this month, if you are wondering what M17 stands for, it is not related to anything technical. It is named for the street address of the club that SP5WPP belonged to at the time it was conceived—Mokotowska 17—in Warsaw, Poland.

On to a different and older aspect of digital communications. In the 1980s something called Packet Radio took the ham community by storm. It was an upgrade of RTTY (Radio TeleTYpe) keyboard to keyboard communications on VHF+. With tones based on the well known Bell 202 MODEM (MOdulator DEModulator) and a serious upgrade in speeds from 45.5 baud to 1200 baud, Packet Radio also offered inherent error correction and the ability to pass data from one station to another, through several that might be located along the way. All of this and more were contained in an intelligent, microprocessor-driven MODEM known as a TNC (Terminal Node Controller).

TNCs were designed to connect to either a dumb terminal or personal computer with an RS-232C serial port and appropriate terminal emulation software. With all of this, TNCs also possessed mailboxes where you could exchange email messages with the TNC owner or other hams withing range.

In utilizing the AX.25 networking protocols (a ham radio extended version of X.25) additional TNCs were configured with NETROM firmware (by installing specifically programmed Read Only Memory chips). Soon, a global network emerged. It was possible to exchange messages with other hams across the world, sometimes moving back and forth within a minute or less, as some high-speed network backbone paths were developed.

While much of the traffic involved was routine stuff,

In decades past, MFJ and other companies must have sold TNCs in six figure quantities. The MFJ-1270 represented the simplest form of TNC, with other models as enhancements or even able to support a variety of modes, such as RTTY, SSTV and CW. (Courtesy: MFJ Enterprises)

Packet Radio offered much for hams in urgent or emergency situations. While there are times that DV is needed for immediacy, accuracy is best left to textual content, such as in the need for supplies or specific medications.

Then this exciting thing came along, known as APRS (Automatic Packet Reporting System) with GPS / GNSS telemetry possible as a component of the packets being exchanged, plus weather telemetry and other advantages over its predecessor. Something it did not offer was the degree of error correction and lengthy messaging that Packet Radio offered.

Instead of adding APRS as another tool in the toolbox, many hams considered this new technology to be more of an "exclusive or" logic condition, rather than an "or." Both concepts offered advantages over the other and should have been used together, but alas, they were not.

Today, many hams still have one or more TNCs sitting unused in boxes or on shelves. Some had their ROMs swapped out to support APRS. Often, you can find used TNCs at hamfests, for a mere fraction of what they sold for new. More to the point, they can be acquired for a mere fraction of their true worth.

APRS is good at passing pre-loaded messages (WA3UVV on station, Accident / flooding / tornadic activity at my location, Going on break for 15, etc.) but the message length is limited. Building up a small yet intelligent terminal from an Arduino, display and keyboard is simple and inexpensive. The same hardware can also support TNC functionality or an older, dedicated, TNC can be used to convey important logistics and other critical needs.

With a station functioning as a digipeater for Packet Radio traffic, multiple stations can exchange data in ways that allow us to serve our communities in times of need.

What would it take for an amateur radio club to (re) establish a Packet Radio presence and make use of it as a valuable tool? A case study on this will be coming up. Until then, give the topic some thought and discussion at your next club or EMCOMM team meeting. Take an inventory of what unused TNC, radio, terminal, antenna combinations and other items each of you has, that could be converted into usable solutions. Perhaps a spark will be lit in your community, as another way to communicate digitally.

TSM